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**A LOWER TERTIARY FORAMINIFERAL FAUNA
FROM MANTA, ECUADOR**

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PLATE 22

A LOWER TERTIARY FORAMINIFERAL FAUNA
FROM SANTA EUGENIA

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INTRODUCTION

The Foraminifera described and figured in this paper were collected near Manta, Ecuador, by Mr. M. N. Bramlette, of the South American Gulf Oil Company, which company has kindly given permission for the fauna to be published. The material was collected from a silty shale at the surface, and all the species are from the same sample. Many of the more fragile specimens have been broken in collecting or washing.

The fauna is of special interest in being the third and largest occurrence of small Foraminifera to be described from South America. One species was described by Bornemann, from the Tertiary of Rio de Janeiro¹, and twenty-five species were listed and five species and one variety described by Berry from Peru.²

There are included in this paper eighty-eight species and varieties, belonging to thirty-nine genera. There are ten new species and one variety. It is remarkable, in view of the fact that so few small fossil Foraminifera have been described from South America, that there are so few new species in the Ecuador fauna. The identifications have been made with extreme care, and in all cases where identifications have been made the Ecuador specimens are almost identical with the published figures. The specimens have been compared in all cases, excepting that of *Quinqueloculina angusta* (Philippi), with the original figures and descriptions. The international Rules of Zoological Nomenclature have been strictly adhered to. In cases where the names or definitions of genera are not agreed upon by recent authorities, the synonymies and descriptions of the genera are included. The classification is that of the senior author.

The age of the fauna is not known to us except by what the Foraminifera themselves indicate. The age cannot be told by the percentage of like species which have been reported from different horizons. The type specimens of the species with which the Ecuadorean species have been identified came from the following horizons: 11 from the Eocene, 15 from the Oligocene, 12

¹Bornemann, in Erman's Archiv Wiss. Kunde Russland, vol. 14, 1855, p. 153, pl. 1, figs. 5-15.

²Berry, Eclogae Geol. Helvetiae, vol. 21, no. 1, 1928, p. 130, figs. 1-6.

from the Miocene, 17 from the Pliocene, 1 from the Pleistocene and 18 from the Recent. On the basis of specialized forms, such as *Nodosarella camerani* (Dervieux), the age is upper Eocene. The fauna bears greatest resemblance in general to the following described faunas: Eocene and Lower Oligocene of Hungary, described by Hantken; Upper Eocene of Texas, described by Cushman and Applin; Lower Eocene of Texas, described by Mrs. Plummer; Upper Eocene of Mexico, described by Cole; and Pliocene of Kar Nikobar, described by Schwager. There are no well known guide fossils, such as the orbitoids and nummulites.

On the whole, we judge the fauna to be Upper Eocene in age.

SYSTEMATIC DESCRIPTIONS

Family MILIOLIDAE d'Orbigny, 1846

Genus QUINQUELOCULINA d'Orbigny, 1826

Quinueloculina angusta (Philippi)

Plate 3, fig. 3

Triloculina angusta Philippi, Tertiar. nordwest. Deutsch., 1843, p. 43, pl. 1, fig. 40.

Quinqueloculina angusta Reuss, Sitz. k. Ak. Wiss. Wien, Math.-Naturw. Cl., vol. 18, 1856, p. 253, pl. 9, fig. 90. (Upper Oligocene.)

Test elongate, elliptical, one side flat, the other inflated; chambers well marked, round in section; sutures depressed; surface smooth; aperture at the end of a short neck, round, without tooth. Length, 0.5 mm.; breadth, 0.23 mm. Abundant.

Genus SIGMOILINA Schlumberger, 1887

Sigmoilina celata (Costa)

Plate 3, fig. 4

Spiroloculina celata Costa, Mem. Accad. Sci. Napoli, vol. 2, 1855 (1857), 126, pl. 1, fig. 14; Atti Accad. Pontiana, vol. 7, fasc. 2, 1856, no description, pl. 26, fig. 5. (Pliocene.)

Planispirina celata Brady, Rep. Voy. Challenger, Zool., vol. 9, 1884, p. 19, pl. 8, figs. 1-4. (Recent.)

Test subelliptical in side view, the ends somewhat pointed, unequally biconvex; chambers very little inflated, about five

on a side; sutures obscure; wall thin, covered with fine sand grains; the interior is smooth; aperture terminal, round, or closed with sand grains. Length, up to 0.93 mm. Abundant.

The wall is very thin and the wall of the last chamber is either broken out or uncompleted in all our specimens, and the apertures are closed.

Family GLOBIGERINIDAE Carpenter, 1862

Genus GLOBIGERERINA d'Orbigny, 1826

***Globigerina bulloides* d'Orbigny**

Plate 3, fig. 5

Globigerina bulloides d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 277, no. 1; Modèles, no. 17 and no. 76; Voy. Amér. Mérid., vol. 5, pt. 5, 1839, p. 37; in Barker, Webb and Bertholet, Hist. Nat. Iles Canaries, vol. 2, pt. 2, Foram., 1839, p. 132, pl. 2, figs. 1-3, 28. (Recent.)

Test composed of about ten globular chambers, rapidly enlarging, four in the last whorl; sutures deep; wall thick, coarsely perforate; surface reticulate; aperture an elongate slit opening into the umbilicus. Length, 0.28 mm.; breadth, 0.23 mm. Common.

***Globigerina compressa* Plummer**

Plate 3, fig. 6

Globigerina compressa Plummer, Univ. Texas, Bull. 2644, 1926 (1927), p. 135, pl. 8, fig. 11 a-c. (Eocene.)

Test rotaliform, unequally biconvex, the ventral side more convex than the dorsal; periphery lobulate; peripheral margin subangular; chambers inflated, six in the last whorl; sutures depressed, curved on both sides of the test; wall hyaline, medium coarsely perforate; surface granulate, aperture on the ventral side, at the base of the last chamber, extending from the umbilicus nearly to the periphery, with slight lip. Diameter, 0.2 mm. Rare.

Our specimens are not as compressed as the Texas form, but otherwise they are very similar.

***Globigerina conglomerata* Schwager**

Plate 3, fig. 7

Globigerina conglomerata Schwager, Novara-Exped., Geol. Theil, vol. 2, 1866, p. 255, pl. 7, fig. 113. (Pliocene.)

Globigerina bulloides var. *quadripartita* Koch, Eclogae Geol. Helvetiae, vol. 19, pt. 3, 1926, p. 745, text fig. 20. (Middle Tertiary.)

Test globular, high spired; chambers elongate dorso-ventrally, inflated, the last one smaller than the penultimate, and usually depressed, four in the last whorl, forming a restricted, rectangular, deep, straight-sided umbilicus or vestibule; sutures deep; wall coarsely perforate and granulate; aperture opening at the bottom of the vestibule, not generally visible from the exterior. Length, up to 0.7 mm. Abundant.

This species differs from the Pleistocene *G. quadrilaterata* Galloway and Wissler (Jour. Pal., vol. 1, 1927, p. 44) in the larger size, elongate chambers, higher spire, and deep vestibule.

Globigerina pseudobulloides Plummer

Plate 3, fig. 8

Globigerina pseudo-bulloides Plummer, Univ. Texas Bull. 2644, 1926, (1927), p. 133, pl. 8, fig. 9. (Eocene.)

Test oval in dorsal view, consisting of about nine inflated chambers, five chambers in the last whorl; spire depressed; sutures deep; wall coarsely perforate and granulate; aperture slit-like, extending from the umbilicus toward the periphery. Length, 0.33 mm.; breadth, 0.27 mm. Abundant.

This species is related to *G. cretacea* rather than to *G. bulloides*. It differs from *G. cretacea* in not having the aperture in the umbilicus, and from *G. bulloides* in having more chambers in a whorl, the chambers enlarge less rapidly, and the aperture is not in the umbilicus. ,

Globigerina trilocularis d'Orbigny

Plate 3, fig. 9

Globigerina trilocularis d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 277, no. 2.—Fornasini, Rend. Sess. R. Accad. Sci. Isti. Bologna, n. s., vol. 2, 1898, p. 12, fig. 2, pl. 1, figs. 6-7. (Pliocene.)

Test composed of about seven or eight globular chambers, three or three and a half in the last whorl, the last chamber nearly as large as the remainder of the test; spire depressed; sutures deep; wall coarsely perforate and granulate; aperture an arch opening into the umbilicus. Length, up to 0.4 mm. Common.

This species differs from *G. triloba* Reuss in not having accessory dorsal apertures. It differs from *G. bulloides* in having only three chambers in the last whorl.

Family LAGENIDAE Reuss, 1861

Genus LENTICULINA Lamarck, 1804

Lenticulina occidentalis novangliae (Cushman) Plate 1, fig. 1

Cristellaria occidentalis var. *novangliae* Cushman, U. S. Nat. Mus. Bull. 104, pt. 4, 1923, p. 104, pl. 23, fig. 1; pl. 24, fig. 1. (Recent.)

Test ovate, biconvex, close-coiled; periphery with a sharp, limbate keel of clearer shell material; chambers eight in the last whorl, the last one drawn out to a point at the apical end; apertural face flat; sutures slightly limbate and curved; aperture produced, at the periphery of the last chamber, small, round, radiate. Length, 0.7 mm.; breadth, 0.56 mm. Rare.

Lenticulina theta Cole Plate 1, fig. 2

Lenticulina theta Cole, Bull. Am. Pal., vol. 14, no. 51, 1927, p. 14, pl. 1, fig. 17. (Eocene.)

Test ovate, biconvex, close-coiled; periphery with limbate keel, not flanged; chambers seven, gradually increasing in size, the later ones typically triangular in shape, embracing to the umbo, the last chamber drawn out to a point at the apical end; sutures flush, slightly limbate; surface smooth; wall thick; aperture small, round, radiate. Length, 0.45 mm.; diameter, 0.35 mm. Rare.

The Ecuador specimen is exactly like the type, figured by Cole from the Guayabal, Eocene of Mexico.

Genus FLABELLINA d'Orbigny, 1839

Flabellina budensis Hantken Plate 1, fig. 3

Flabellina budensis Hantken, A magy. kir. földt. int. évkönyve, 4, 1875 (1876), p. 37, pl. 4, fig. 17; Mitth. Jahrb. k. ungarn. geol. Anstalt, vol. 4, pt. 1, 1875 (1881), p. 44, pl. 4, fig. 17. (Lower Oligocene.)

Test very flat and broad, elongate to ovate, coming to a blunt and often apiculate point at the apical end; chambers numerous, narrow, closely appressed, partially coiled in the early portion of the test, later chambers V-shaped, forming an angle towards the aperture of about twenty-five or more degrees; sutures of clear shell material, slightly depressed; surface smooth; aperture

terminal. Length, 0.55 mm. to 0.66 mm.; breadth, 0.4 mm. Abundant.

Genus FRONDICULARIA Defrance, 1824

Frondicularia striata d'Orbigny

Plate 1, fig. 4

Frondicularia striata d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 256, no. 3.
—Parker, Jones and Brady, Ann. Mag. Nat. Hist., ser. 4, vol. 8, 1871, p. 161, pl. 10, fig. 67, from Soldani.—Fornasini, Mem. R. Accad. Sci. Isti. Bologna, Sez. Sci. Nat., ser. 5, vol. 9, 1901, p. 45, pl. 3, fig. 12. (Pliocene - Recent.)

Test elongate, much compressed, gradually tapering; periphery keeled; initial end bluntly rounded; chambers numerous, narrow, V-shaped, making an acute angle towards the aperture of about sixty degrees, closely appressed; wall thicker in the early portion of the test, strongly costate longitudinally, about ten costae on one side; aperture terminal, round. Length of broken specimen, 1.1 mm.; breadth, 0.35 mm. Common.

The Ecuador specimen is almost exactly like the one figured by Fornasini from the Pliocene of Bologna.

Genus MARGINULINA d'Orbigny, 1826

Marginulina sp.

Plate 1 fig. 5

Test stout, curved, the initial end bulbous in a megaspheric specimen; chambers few, three in a broken specimen, inflated, decreasing in size as added; showing a slight vestigial coil; sutures distinct; surface smooth; aperture central, large, round, not definitely radiate. Length, 0.7 mm.; breadth, 0.4 mm. Rare.

The one broken specimen cannot be even generically identified with certainty.

Genus GLANDULINA d'Orbigny, 1826

Glandulina laevigata (d'Orbigny)

Plate 1, fig. 6

Nodosaria (sous-genre *Glandulina*) *laevigata* d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 252, no. 1, pl. 10, figs. 1-3. (Pliocene to Recent.)

Glandulina laevigata d'Orbigny, Foram. Foss. Bass. Tert. Vienne, 1846, p. 20, pl. 1, figs. 4-5. (Miocene.)—Chapman and Parr, Jour. Linn. Soc. London, Zool., vol. 36, 1926, p. 378, pl. 17, fig. 20. (Jurassic to Recent.)

Test fusiform; chambers three to four visible, the last-formed one constituting two-thirds of the test; sutures flush, distinct; surface smooth; aperture terminal, produced, round, small, radiate. Length, 0.94 mm.; breadth, 0.6 mm. Rare.

***Glandulina comata* (Batsch)**

Plate 1, fig. 7

***Nautilus comatus* Batsch**, Conch. Seesands, 1791, pl. 1, fig. 2 c-d. (Recent.)

***Glandulina comata* Fornasini**, Mem. R. Accad. Sci. Isti. Bologna, Sez. Sci. Nat. ser. 5, vol. 8, 1899-1900, pp. 93-138, text figure 29; pl. 5, fig. 29. (Recent.)

Test pyriform, apiculate; chambers few, not well marked; surface marked by about twenty-four distinct costae, which run about three-quarters of the way up the test, leaving the last quarter smooth; aperture terminal, large, round, radiate. Length, 0.65 mm.; breadth, 0.43 mm. Rare.

The Ecuador specimen is very like the specimen figured by Fornasini from the Recent of Porto Corsini, Italy.

Genus DENTALINA d'Orbigny, 1826 (1840)

***Dentalina pauperata* d'Orbigny**

Plate 1, fig. 8

***Dentalina pauperata* d'Orbigny**, Foram. Foss. Bass. Tert. Vienne, 1846, p. 46, pl. 1, figs. 57-58. (Miocene.)—Bornemann, Zeitschr. deutsch. geol. Gesell., vol. 7, 1855, p. 324, pl. 13, fig. 7. (Middle Oligocene.)—Franke, Abh. Ber. Mus. Natur Heimat. Naturw. Ver. Magdeburg, vol. 4, pt. 2, 1925, p. 166, pl. 5, fig. 26. (Lower Oligocene.)

Test elongate, curved, round in cross section; chambers numerous, (seven in a broken specimen), gradually enlarging, early ones closely appressed and cylindrical, last two or three somewhat bulbous; sutures distinct, slightly oblique, especially in the later portion, limbate in the earlier part of the test, of clear shell material, constricted between the last two or three chambers; surface smooth; aperture protruding, round, radiate, near the concave side of the test. Length, 1.7 mm. Rare.

Our specimens have the initial end broken off so that we cannot tell whether or not there was an apical spine, as in d'Orbigny's specimens.

Genus **NODOSARIA** Lamarck, 1812**Nodosaria acuminata** Hantken

Plate 1, fig. 9

Nodosaria acuminata Hantken, A magy. kir. földt. int. évkönyve, 4, 1875 (1876), p. 23, pl. 2, fig. 9; pl. 13, fig. 5; Mitth. Jahrb. k. ungarn. geol. Anstalt, vol. 4, pt. 1, 1875 (1881), p. 28, pl. 2, fig. 9; pl. 13, fig. 5. (Oligocene.)—Cushman, Jour. Pal., vol. 1, no. 2, 1927, p. 155, pl. 24, fig. 9. (Lower Oligocene.)

Test elongate, slender, nearly straight, gradually tapering towards the apical end, which usually has a short apical spine; chambers somewhat inflated, eleven in a broken specimen; sutures distinct, depressed, of clear shell material; surface ornamented with six prominent, longitudinal costae which are continuous throughout the length of the test; aperture round, not produced, minutely radiate. Length, 0.84 mm. Common.

Nodosaria vertebralis (Batsch)

Plate 1, fig. 10

Nautilus vertebralis Batsch, Conch. Seesands, 1791, pl. 2, fig. 6 a-b. (Recent.)

Nodosaria vertebralis Brady, Rep. Voy. Challenger, Zool., vol. 9, 1884, p. 514, pl. 63, fig. 35; pl. 64, figs. 11-14.—Cushman, U. S. Geol. Surv. Prof. Pap. 133, 1923, p. 27, pl. 4, fig. 1.—Plummer, Univ. Texas Bull. 2644, 1926 (1927), p. 88, pl. 5, fig. 10. (Eocene.)

Nodosaria obliqua Cushman, U. S. Geol. Surv. Prof. Pap. 129 F, 1921, p. 129, pl. 30, fig. 6. (Eocene to Recent.)

Test elongate, tapering, slightly curved, with an apical spine; chambers numerous, ten in a broken specimen, slightly inflated, broader than long, the initial chamber bulbous; (megaspheric specimen); sutures limbate, of clear shell material; surface ornamented with twelve or more prominent, coarse, longitudinal costae, some of which are continuous throughout the length of the test, others are intercalated; aperture round, radiate. Length, 1.9 mm. Rare.

The Ecuador specimen is almost exactly like the one figured by Cushman from the Middle Oligocene of Mississippi.

Nodosaria obliquestriata (Reuss)

Plate 1, fig. 11

Dentalina obliquestriata Reuss, Zeitschr. deutsch. geol. Gesell., vol. 3, 1851, p. 63, pl. 3, figs. 11-12. (Middle Oligocene.)

Test elongate, cylindrical, straight; chambers in broken specimens three, which are distinctly marked by deep sutures; surface

smooth, except for about ten slightly oblique, longitudinal striae which cross the sutures but become obsolescent on the middle of the chambers; aperture round. Length of broken specimen, 0.75 mm. Rare.

Nodosaria sp.

Plate 1, fig. 12

Nodosaria sp. Cole, Bull. Am. Pal., vol. 14, no. 51, 1927, p. 17, pl. 1, fig. 21. (Eocene.)

Test elongate, with apical spine; consisting of three inflated chambers; sutures depressed, not oblique; surface provided with about ten prominent, sharp costae, five of which arise on one chamber and fade out in the next one above, where five other, alternating costae arise and fade out in the next chamber above; aperture round, doubtfully radiate. Length, 0.72 mm. Rare.

This is probably a new species but is not named as such on account of the imperfect conditions of our specimens. The Ecuador specimen is like the one figured by Cole from the Guayabal, Eocene of Mexico.

Nodosaria consobrina (d'Orbigny)

Plate 1, fig. 13

Dentalina consobrina d'Orbigny, Foram. Foss. Bass. Tert. Vienne, 1846, p. 46, pl. 2, figs. 1-2. (Miocene.)—Bornemann, Zeitschr. deutsch. geol. Gesell., vol. 7, 1855, p. 323, pl. 13, figs. 1-4. (Middle Oligocene.)—Neugeboren, Denkschr. k. Ak. Wiss. Wien, Math.-Naturw. Cl., vol. 12, pt. 2, 1856, p. 86, pl. 3, fig. 15. (Miocene.)—Cushman and Hanna, Proc. Calif. Acad. Sci., ser. 4, vol. 16, no. 8, 1927, p. 214, pl. 13, figs. 12-13. (Eocene.)

Test elongate, slender, slightly curved, with an apical spine; chambers five in a broken specimen, increasing in size, the later ones twice as long as broad; sutures distinct, constricted, not oblique; surface smooth; aperture round, radiate. Length, 1.2 mm. Common.

This species is a generalized form which is of little value in correlation. It has been recognized from the Middle Jurassic to the Recent.

Nodosaria emaciata (Reuss)

Plate 1, fig. 14

Dentalina emaciata Reuss, Zeitschr. deutsch. geol. Gesell., vol. 3, 1851, p. 63, pl. 3, fig. 9. (Middle Oligocene.)

Test elongate, slender, tapering, curved, the initial end bulbous;

chambers ten in a broken specimen, elongate, increasing in size, the later ones twice as long as broad; sutures depressed, not oblique, limbate, of clear shell material; surface smooth, transparent; aperture round, doubtfully radiate. Length, 0.9 mm. Common.

Nodosaria arundinea Schwager

Plate 1, fig. 15

Nodosaria arundinea Schwager, *Novara-Exped.*, Geol. Theil, vol. 2, 1866, p. 211, pl. 5, figs. 43-45. (Pliocene.)—Sherborn and Chapman, *Jour. Roy. Micr. Soc.*, ser. 2, vol. 6, 1866, p. 747, pl. 14, figs. 28-29. (Lower Eocene.)—Cushman and Hanna, *Proc. Calif. Acad. Sci.*, ser. 4, vol. 16, no. 8, 1927, p. 215, pl. 13, fig. 14. (Eocene.)

Nodosaria calamus Silvestri, *Atti Accad. Gioenia Sci. Nat. Catania*, ser. 3, vol. 7, 1872, p. 87, pl. 10, figs. 243-251. (Pliocene.)

Test slender, very elongate, straight, subcylindrical; chambers two to three times as long as broad, probably numerous though no complete specimen was found; sutures indistinct, somewhat depressed; surface smooth; aperture round, probably radiate, indistinct in our specimens. Length, 1.1 mm. Common.

Nodosaria pyrula of authors

Plate 1, fig. 16

Nodosaria pyrula Cushman (not d'Orbigny), *U. S. Nat. Mus. Bull.* 71, pt. 3, 1913, p. 49, pl. 26, figs. 1-3; *Bull.* 104, pt. 4, 1923, p. 69, pl. 16, figs. 1-4. (Recent.)

Several broken specimens of one chamber each. The chambers are fusiform to pyriform, the extremities being long and narrow; surface smooth; wall finely perforate; aperture round, doubtfully radiate. Length, 0.5 mm. Common.

On account of the absence of the complete test the form cannot be certainly identified.

Nodosaria sp.

Plate 1, fig. 17

Several broken segments of a strangulated *Nodosaria* were found but no complete ones. Each specimen shows the broken attachment to a previous chamber and a round, non-radiate aperture at the end of a long, tapering neck. The open lower side shows that it is not *Lagena*. Common.

Nodosaria adolphina (d'Orbigny)

Plate 2, fig. 1

Dentalina adolphina d'Orbigny, *Foram. Foss. Bass. Tert. Vienne*, 1846, p.

51, pl. 2, figs. 18-20. (Miocene.)—Borneman. Zeitschr. deutsch. geol. Gesell., vol. 7, 1855, p. 324, pl. 13, fig. 5. (Middle Oligocene.)—Gümbel, Abh. k. bay. Ak. Wiss., München, Math.-Phys. Cl., vol. 10, for 1868 (1870), p. 623, pl. 1, fig. 39. (Eocene.)—Cushman and Hanna, Proc. Calif. Acad. Sci., ser. 4, vol. 16, no. 8, 1927, p. 213, pl. 13, figs. 8-9. (Eocene.)

Test elongate, slender, gradually enlarging; chambers subglobular, three in a broken specimen; sutures constricted, not oblique; surface smooth except for two annuli of spines on the lower third of each chamber; aperture small, round, central, doubtfully radiate. Length, 0.4 mm. Rare.

Nodosaria lepidula Schwager

Plate 2, fig. 2

Nodosaria lepidula Schwager, Novara-Exped., Geol. Theil, vol. 2, 1866, p. 210, pl. 5, figs. 27-28. (Pliocene.)

Test elongate, slender; chambers three in a broken specimen, bulbous; sutures distinct, very much constricted; surface smooth except for an annulus of five to eight spines on the lower third of each chamber; aperture large, round, doubtfully radiate. Length, 0.5 mm. Rare.

This species differs from *N. adolphina* (d'Orbigny) in having only one annulus of spines whereas *N. adolphina* has two annuli of spines.

Nodosaria annulifera Gümbel

Plate 2, fig. 3

Nodosaria annulifera Gümbel, Abh. k. bay. Ak. Wiss., München, Math.-Phys. Cl., vol. 10, for 1868 (1870), p. 614, pl. 1, fig. 21. (Eocene.)

Test elongate, straight, gradually tapering; chambers globular, six in a broken specimen; sutures constricted, depressed; surface smooth, granular in calcified specimens; aperture small, round, slightly produced, indistinctly radiate. Length, 0.32 mm. Rare.

This species is more slender than *N. radricula* (Linné) and the chambers are closer together and less nearly spherical.

Nodosaria holserica Schwager

Plate 2, fig. 4

Nodosaria holserica Schwager, Novara-Exped., Geol. Theil, vol. 2, 1866, p. 221, pl. 5, fig. 49. (Pliocene.)

Test short, consisting of two rather large, bulbous chambers; sutures constricted; surface granular in appearance due to numerous minute spines; aperture round, at the end of a long protruding neck, obscurely radiate. Length, 0.5 mm. Rare.

The Ecuador specimen is exactly like the type figure of Schwager's.

Nodosaria conspurcata Reuss

Plate 2, fig. 5

Nodosaria conspurcata Reuss, Zeitschr. deutsch. geol. Gesell., vol. 3, 1851, p. 59, pl. 3, fig. 3; Sitz. k. Ak. Wiss. Wien. Math.-Naturw. Cl., vol. 48, 1863 (1864), p. 43, pl. 2, figs. 10-12; Denkschr. k. Ak. Wiss. Wein, Math.-Naturw. Cl., vol. 25, 1865, p. 130, pl. 2, figs. 19-21. (Middle Oligocene.)—Franke, Abh. Ber. Mus. Natur Heimat. Naturw. Ver. Magdeburg, vol. 4, pt. 2, 1925, p. 166, pl. 5, fig. 25. (Lower Oligocene.)

Test short, stout, consisting of two or more bulbous chambers; sutures constricted; surface covered with numerous short, stout spines; aperture at the end of a protruding neck, round, doubtfully radiate; broken off in our specimen. Length, 0.6 mm. Rare.

Genus LAGENONODOSARIA Silvestri, 1900

Genotype (monotypic), **Lagenonodosaria separans** (Brady) = **Nodosaria scalaris** var. **separans** Brady, Rep. Voy. Challenger, Zool., vol. 9, 1884, p. 511, pl. 64, figs. 16-19. (Recent, off New Zealand, 275 fathoms.)

Lagenonodosaria Silvestri, Atti Rend. R. Accad. Sci. Lett. Arti Zelanti, Acireale. Mem. Cl. Sci., vol. 10, 1900, p. 12; Atti Pont. Accad. Rom. Nuovi Lincei, vol. 55, 1902, p. 56, figs. 4-9; vol. 57, 1904, p. 144.

Nodogenerina Cushman, Contrib. Cushman Lab. Foram. Res., vol. 2, 1927, p. 79; vol. 3, 1927, p. 63; Foraminifera, 1928, p. 240.

Test free, straight or slightly curved, round in section, with or without apical spine; chambers several, closely appressed throughout or closely appressed in the early portion and separated by necks in the later portion or separated by necks throughout; sutures distinct, at right angles to axis of test, except in the early portion of the microspheric form where they may be slightly oblique; walls calcareous, hyaline, finely perforate, smooth, spinose or costate; aperture single, round, small, at the end of a long neck, with or without phialine lip, sometimes rudimentarily radiate. Length up to 8 mm. or more.—Shallow to deep, usually warm water.—Jurassic (?), Cretaceous to Recent, common.

Many species of *Nodosaria* of authors belong to *Lagenonodosaria*, which differs from *Nodosaria* in the long neck and phialine aperture which is imperfectly or not at all radiate.

Lagenonodosaria monilis (Silvestri)

Plate 3, fig. 1

Nodosaria monilis Silvestri, Atti Accad. Gioenia Sci. Nat., ser. 3, vol. 7, 1872, p. 71, pl. 8, figs. 173-183. (Pliocene.)

Nodosaria monile Fornasini, Mem. R. Accad. Sci. Isti. Bologna, Sez. Sci.

Nat., ser. 5, vol. 8, 1900, p. 115, pl. 7, fig. 28. (Recent.)

Test elongate, straight, gradually enlarging; chambers bulbous, two in broken specimens; sutures very much constricted giving a strangulated appearance; surface covered with two to four annuli of short, thick spines which point toward the apical end, those of one annulus alternating with those in preceeding and succeeding annuli; aperture terminal, central, round, not radiate. Length of broken specimen, 0.5 mm. Rare.

Silvestri's species appears to be a *Lagenonodosaria* rather than a *Nodosaria* on account of the aperture with phialine lip, not radiate as in *Nodosaria*.

Genus LAGENA Walker and Boys, 1784

Lagena asperoides n. sp.

Plate 2, fig. 6

Lagena aspera Cushman, U. S. Nat. Mus. Bull. 71, pt. 3, 1913, p. 16, pl. 16, fig. 1. (Recent.)

Test spherical, except for a long, tapering neck; surface covered with numerous short, thick spines; aperture round, at the end of the neck, with phialine lip. Length, 0.57 mm; breadth, 0.36 mm. Common.

Holotype. Columbia University Paleo. Coll. No. 19952.

This species differs from *L. hystrix* Reuss in the conical, rather than cylindrical shape of the spines, and from *L. aspera* Reuss in the spherical shape and long, large neck. It seems to be exactly like the Recent *L. aspera* of Cushman (not Reuss), which he states has been found in the Eocene, Oligocene, Miocene, Pleistocene and Recent.

Lagena semistriata Williamson

Plate 2, fig. 7

Lagena vulgaris var. **semistriata** Williamson, Rec. Foram. Great Britain, 1858, p. 6, pl. 1, fig. 9. (Recent.)

Test ovate, globular, apiculate, with about twenty-two, thick, longitudinal costae which commence a short distance from the short, apiculate spine and disappear towards the apertural end, leaving the last two-fifths of the test smooth; aperture round, at the end of a long neck, which is broken off in our specimen. Length, 0.42 mm; breadth, 0.37 mm. Rare.

Lagena strumosa Reuss

Plate 2, fig. 8

Lagena strumosa Reuss, Zeitschr. deutsch. geol. Gesell., 1858, p. 434, no fig.; Sitz. k. Ak. Wiss. Wien, Math.-Naturw. Cl., vol. 46, pt. 1, 1862 (1863), p. 328, pl. 4, fig. 49. (Oligocene-Miocene.)

Test bulbous, with short spines and long apertural neck; surface ornamented with about twenty-five fine, longitudinal costae; wall very finely perforate; aperture round, with phialine lip; the neck is broken off in our specimens. Length, 0.3 mm; breadth, 0.23 mm. Common.

Lagena sulcata apiculata Cushman

Plate 2, fig. 9

Lagena sulcata var. **apiculata** Cushman, U. S. Nat. Mus. Bull. 71, pt. 3, 1913, p. 23, pl. 9, figs. 3-4. (Recent.)

Test bulbous, with sixteen distinct costae which extend from the apical end to a ring at the base of the neck; apical end probably drawn out into a spine which is broken off in our specimen; aperture round, at the end of a long, tapering neck which has an annulus near its base, probably representing the beginning of a second chamber. Length, 0.36 mm; breadth, 0.24 mm. Rare.

The annulus at the neck of this form, and the apertural neck show that it was derived from *Lagenonodularia*, and the annulus is a vestage of an undeveloped chamber.

Genus ROBULUS Montfort, 1808**Robulus calcar** (Linné)

Plate 2, fig. 10

Nautilus calcar Linné, Syst. Nat., ed. 10, 1758, p. 709; ed. 13 (Gmelin's), 1788, p. 3370, named from figures by Plancus, De Conchis Minus Notis, 1739, p. 1, pl. 12, figs. 3-4, or Gaultieri, Test. Conch. Index, 1742, pl. 19, fig. c. (Recent.)

Cristellaria calcar Cushman, U. S. Nat. Mus. Bull. 104, pt. 4, 1923, p. 115, pl. 31, fig. 4. (Recent.)

Test discoidal, biconvex, close-coiled, biumbonate; periphery with narrow keel and three or four short spines; chambers few, about four to six, triangular; sutures indistinct, curved; surface smooth; aperture an elongate slit on the face of the last chamber, near the periphery, radiate on the outside. Diameter, 0.44 mm. Abundant.

The figure of Plancus has no spines on the periphery, whereas

that of Gaultieri, which our specimens closely resemble, has short spines.

Robulus cf. deformis (Reuss)

Plate 2, fig. 11

Robulina deformis Reuss, Zeitschr. deutsch. geol. Gesell., vol. 3, 1851, p. 70, pl. 4, fig. 30. (Middle Oligocene.)

Test bulbous, trihedral, consisting of two chambers commencing to coil, with carina on the outside edge and two ridges on the inner side of the chambers; proloculum very large; surface smooth; aperture a vertical slit at the apex of the last chamber, near the periphery, radiate outside. Diameter, 0.38 mm. Common.

Our specimens are very young megaspheric ones and cannot therefore be identified exactly.

Robulus deformis (Reuss) var.

Plate 2, fig. 12

This specimen differs from the others of the species in having two costae on one side of the proloculum. Diameter, 0.38 mm. Rare.

Robulus duracina (Stache)

Plate 2, fig. 13

Cristellaria duracina Stache, Novara-Exped., vol. 1, pt. 2, 1864, p. 237, pl. 23, fig. 16 a-b. (Middle Tertiary.)

Test discoidal, strongly biconvex; periphery angled; chambers twelve to fifteen in the last whorl; sutures slightly curved, limbate, tangential to the earlier whorl; aperture round, small, terminal, slightly produced, finely radiate, with secondary aperture near the principal one, on the outer face of the septum, oval with raised rim. Diameter, 0.6 mm. Rare.

Robulus taettowata (Stache)

Plate 2, fig. 14

Robulina taettowata Stache, Novara-Exped., vol. 1, pt. 2, 1864, p. 252, pl. 23, fig. 32 a-b. (Middle Tertiary.)

Test lenticular, umbonate, with narrow, rounded carina which extends down the sides of the last septal face; surface smooth; chambers about six to a whorl, which embrace to the umbo; sutures slightly curved, broadly limbate, slightly raised in the adult; aperture an elongate slit on the upper edge of the septal face, with coarse radial ridges on the outside, which show near

the periphery on the last three or four chambers. Diameter of adult, 1.1 mm; thickness, 0.63 mm. Abundant.

Genus FISSURINA Reuss, 1850

Fissurina carinata Reuss

Plate 2, fig. 15

Fissurina carinata Reuss, Sitz. k. Ak. Wiss. Wien, Math.-Naturw. Cl., vol. 46, pt. 1, 1862 (1863), p. 338, pl. 6, fig. 83; pl. 7, fig. 86. (Oligocene-Miocene.)—Terquem, Mém. Soc. Géol. France, ser. 3, vol. 2, 1882, p. 31, pl. 1, (19), fig. 23 a-b. (Eocene.)

Test small, compressed, ovate in side view, elliptical in edge view; surface smooth with an angled peripheral keel; wall finely perforate; aperture a narrow, elongate slit, parallel to the flattened sides of the test. Length, 0.2 to 0.25 mm.; diameter, 0.2 mm. Rare.

One of our specimens is like that which Reuss had and the other, which is a broader specimen, is exactly like that which Terquem had in his material from the Eocene near Paris.

Fissurina globosa Bornemann

Plate 2, fig. 16

Fissurina globosa Bornemann, Zeitschr. deutsch. geol. Gesell., vol. 7, 1855, p. 317, pl. 12, fig. 4. (Middle Oligocene.)

Lagena globosa Jones, Parker and Brady, Pal. Soc. London. pt. 1, 1866, pl. 1, fig. 32. (Pliocene.)

Test bulbous, slightly compressed, pyriform in side view, broadly elliptical in edge view, with a short apical spine; surface smooth except for a sharp, narrow keel on the first half of the test; wall hyaline, finely perforate; aperture a small, elongate slit at the end of a protuberance which is marked at its base by a line of clear shell material, Length, 0.3 mm.; diameter, 0.25 mm. Rare.

The Ecuador specimen is exactly like Borneman's type figure from the Middle Oligocene of Hermsdorf.

Fissurina orbignyana caribaea (Cushman)

Plate 2, fig. 17

Lagena orbignyana var. **caribaea** Cushman, U. S. Nat. Mus. Bull. 104, pt. 4, 1923, p. 41, pl. 7, figs. 6-9. (Recent.)

Test slightly compressed, ovate in side view, pyriform in edge view, with three keels of clear shell material; surface smooth except for the keels, the middle one of which broadens and includes the aperture; the two lateral keels are nearly circular;

wall hyaline, finely perforate; aperture round, at the pointed end of the test, probably entosolenian. Length, 0.5 mm.; breadth, 0.35 mm. Common.

This species differs from *Lagena orbignyana* (Seguenza) in being much thicker, especially at the aboral end.

Fissurina staphyllearia Schwager

Plate 2, fig. 18

Fissurina staphyllearia Schwager, *Novara-Exped.*, Geol. Theil, vol. 2, 1866, p. 209, pl. 5, fig. 24. (Pliocene.)

Test bulbous, very slightly compressed; wall hyaline, finely perforate; surface smooth except for a few short, eccentrically placed, apical spines; aperture an elongate slit, slightly produced. Length, 0.35 mm.; diameter, 0.3 mm. Common.

It is possible that a section of a specimen of this species would show it to be an *Ellipsolagena*.

Fissurina sp.

Plate 2, fig. 19

Lagena marginata Cushman (not *Lagena marginata* Walker and Boys), U. S. Nat. Mus. Bull. 71, pt. 3, 1913, p. 37, pl. 22, figs. 1-7. (Recent.)

Test compressed, subcircular in side view; elliptical in edge view, with broad keel; surface smooth; wall hyaline, finely perforate; aperture fissurine, broken in our specimen. Diameter, 0.45 mm. Rare.

Genus LINGULINA d'Orbigny, 1826

Lingulina sp.

Plate 3, fig. 2

Test minute, flattened, regularly tapering from the rounded initial end; edge broadly rounded; chambers comparatively few, about nine; sutures distinct, depressed; surface smooth; wall conspicuously perforate; aperture terminal, elliptical. Length, 0.23 mm.; breadth, 0.1 mm. Rare.

We have a single specimen of this form which is different from anything described, but more material is needed in order to designate it as a new species.

Family POLYMORPHINIDAE d'Orbigny, 1846

Genus GLOBULINA d'Orbigny, 1826

- Genotype (first species, designated by Cushman, 1927) **Polymorphina (Globulina) gibba** d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 266; Model no. 63, 1826. (Recent, shore at Rochelle.)—Parker, Jones and Brady, Ann. Mag. Nat. Hist., ser. 3, vol. 16, 1865, p. 29, pl. 2, fig. 52.
- Globulina** d'Orbigny, Foram. Foss. Bass. Tert. Vienne, 1846, p. 225.—Cushman, Contrib. Cushman Lab. Foram. Res., vol. 3, pt. 4, 1927, p. 188.
- Raphanulina** Zborzewski, Nouv. Mém. Soc. Imp. Nat. Moscou, vol. 3, 1834, p. 311, pl. 28, fig. 1 a.
- Aulostomella** Alth, Haidinger's Nat. Abh., vol. 3, pt. 2, 1850, p. 264.
- Glandulopolymorphina** Silvestri, Boll. Accad. Gioenia Sci. Nat. in Catania, n. ser., fasc. 69, 1901, p. 17.
- Misilus** Montfort, Conch. Syst., vol. 1, 1808, p. 294, Not definitely recognizable.
- Polymorphina** (part) of authors.

Test free, globular, oval or round in longitudinal and cross sections; chambers few, closely appressed, arranged in a high spire, three to a whorl, usually three chambers visible externally; sutures flush with the surface; wall calcareous, hyaline, finely perforate, smooth, costate or spinose; aperture terminal, slightly produced, round, radiate, frequently fistulose due to degeneration of the last chamber. Length, up to 2 mm.—Mostly in shallow water, but down to over 1500 fathoms.—Jurassic to Recent, more common in Tertiary and Recent.

Globulina ovata d'Orbigny

Plate 3, fig. 10

Globulina ovata d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 266, no. 22.—Forasini, Boll. Soc. Geol. Italiana, vol. 19, 1900, p. 147, text figure 5. (Recent and Miocene.)

Test broadly oval in side view and cross section; chambers greatly embracing, three visible in megaspheric specimens; sutures distinct, flush; surface smooth; aperture terminal, round, radiate. Length of megaspheric specimen, 0.5 mm.; breadth, 0.27 mm. Rare.

Polymorphina ovata d'Orbigny, figured in his Vienna Basin Report, is a different form.

Family ROTALIIDAE Reuss, 1861

Genus GLOBOROTALIA Cushman, 1927

Globorotalia canariensis (d'Orbigny)

Plate 3, fig. 11

Rotalina canariensis d'Orbigny, in Barker, Webb and Berthelot, Hist. Nat. Iles Canaries, vol. 2, pt. 2, Foram., 1839, p. 130, pl. 1, figs. 34-36. (Recent.)

Pulvinulina canariensis Brady, Rep. Voy. Challenger, Zool., vol. 9, 1884, p. 692, pl. 103, figs. 8-10. (Recent.)

Test small, unequally biconvex, ventral side more so, with small umbilicus; peripheral margin acute; periphery lobulate; chambers five in the last whorl; sutures on the dorsal side of clear shell material, and much curved, nearly flush with the surface, depressed on the ventral side, and slightly curved; wall very finely perforate; surface smooth, except the early part of the last whorl which is granulate on the ventral side; aperture an elongate opening extending from the umbilicus part way to the periphery. Length, 0.33 mm.; breadth, 0.27 mm. Abundant.

Genus ROTALIA Lamarck, 1804

Rotalia advena Cushman

Plate 3, fig. 12

Rotalia advena Cushman, U. S. Geol. Surv. Prof. Pap. 133, 1923, p. 46, pl. 7, figs. 4-6. (Oligocene.)

Test unequally biconvex, biumbonate, the dorsal side slightly convex, the umbonal region more elevated, the ventral side deep; peripheral margin angled and limbate; chambers five in the last whorl; sutures on the dorsal side limbate, flush, very little curved, tangential to the previous whorl, scarcely visible on the spire, on the ventral side slightly limbate, very little curved or depressed, radial to the umbo; wall finely perforate; surface smooth, glistening; aperture a narrow slit on the inner margin of the last chamber nearer the periphery than the umbo. Diameter, up to 0.35 mm. Common.

The Ecuador specimens have a sharper peripheral angle than the Alabama types of the species.

***Rotalia ecuadorensis* n. sp.**

Plate 3, fig. 13

Test discoidal, unequally biconvex, the ventral side the deeper, umbonate on both sides, the umbo on the ventral (apertural) side being the more prominent; periphery slightly lobulate; peripheral margin angled; chambers five to six in the last whorl; sutures on the dorsal side flush, of clear shell material, curved and slightly oblique, sutures on the ventral side flush, of clear shell material, slightly curved and nearly radial in the outer half, strongly curved in the inner half, in the umbo; aperture a narrow slit near the periphery on the inner margin of the last chamber, with lip. Diameter, up to 0.36 mm. Common.

Holotype. Columbia University Paleo. Coll. No. 19953.

This species resembles *R. umbonata* but differs in the curved sutures in the ventral umbo, a constant character of the species.

***Rotalia umbonata* (Reuss)**

Plate 4, fig. 1

Rotalina umbonata Reuss, Zeitschr. deutsch. geol. Gesell., vol. 3, 1851, p. 75, pl. 5, fig. 35. (Middle Oligocene.)

Pulvulina umbonata Hantken, A magy. kir. földt. int. évkönyve, vol. 4, 1875 (1876), p. 67, pl. 9, fig. 8; Mitth. Jahrb. k. ungarn. geol. Anstalt, vol. 4, pt. 1, 1875 (1881), p. 77, pl. 9, fig. 8. (Lower Oligocene.)

Truncatulina tenera Brady, Rep. Voy. Challenger, Zool., vol. 9, 1884, p. 665, pl. 95, fig. 11 a-c. (Recent.)—Cushman, U. S. Nat. Mus. Bull. 71, pt. 5, 1915, p. 37, pl. 16, fig. 2; pl. 23, fig. 6. (Recent.)—Plummer, Univ. Texas Bull. 2644, 1926 (1927), p. 146, pl. 9, fig. 5. (Eocene.)

Eponides umbonata Cole, Bull. Am. Pal., vol. 14, 1928, p. 15, pl. 2, fig. 6. (Upper Eocene.)

Test nearly equally biconvex, ventral side more so and without definite umbilicus; dorsal side convex in the middle making an umbo in which the spire is obscured; the outer whorl being flat and lower than the central part; periphery lobulate, peripheral margin acute; chambers five to six in the last whorl; sutures nearly straight and radial on both sides, flush and limbate dorsally, slightly depressed ventrally and curved towards the umbo in gerontic specimens; wall very finely perforate; surface smooth and white; aperture an elongate slit near the periphery on the inner margin of the last chamber, with slight lip. Diameter, up to 0.8 mm. Abundant.

Some gerontic specimens are more ventricose than the normal form, and the last whorl is more involute on the ventral side, making a shoulder between it and the next to the last whorl.

This form is not coarsely perforate and the aperture does not extend over into the dorsal side, hence it is not a *Cibicides* (*Truncatulina* of authors).

Genus *GYROIDINA* d'Orbigny, 1826*Gyroidina laevis* d'Orbigny

Plate 4, fig. 2

Gyroidina laevis d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 278, no. 3. (Recent, Pliocene and Miocene.)—Fornasini, Mem. R. Accad. Sci. Isti. Bologna, Sez. Sci. Nat., ser. 5, vol. 7, 1898, p. 260, fig. 7.

Test unequally biconvex, the dorsal side low, ventral side deep and umbilicate; periphery not lobulate except slightly in the last few chambers; peripheral margin sharply curved; chambers about eleven in the last whorl; sutures on the dorsal side distinct, of clear shell material, slightly curved and nearly radial; sutures between the whorls not depressed; sutures on the ventral side slightly depressed and curved; surface smooth; aperture an elongate slit on the inner margin of the last septal face extending from near the umbilicus to near the periphery. Diameter, 0.3 mm. Common.

This species is less ventricose than the more typical species of the genus *Gyroidina*.

Gyroidina nitidula (Schwager)

Plate 4, fig. 3

Rotalia nitidula Schwager, Novara-Exped., Geol. Theil, vol. 2, 1866, p. 263, pl. 7, fig. 110. (Pliocene.)

Test plano-convex; dorsal side depressed, with a deep groove between the last two whorls and umbonate center in which the spire is scarcely visible; ventral side strongly ventricose, with deep umbilicus; chambers about nine in the last whorl; sutures slightly depressed and curved, deeply depressed near the umbilicus; wall very finely perforate; surface smooth; aperture an elongate slit between the periphery and the umbilicus on the inner margin of the chamber. Diameter, up to 0.9 mm. Common.

This species differs from *Gyroidina soldanii* d'Orbigny, in the larger size of the test and the deeper depression between the last two whorls, and the more closely appressed whorls.

Gyroidina soldanii d'Orbigny

Plate 4, fig. 4

Gyroidina soldanii d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 278, no. 5; Modèles, no. 36.

Rotalina soldanii d'Orbigny, Foram. Foss. Bass. Tert. Vienne. 1846, p. 155, pl. 8, figs. 10-12. (Miocene.)

Rotalia soldanii Hantken, A magy. kir. földt. int. évkönyve, vol. 4, 1875 (1876), p. 69, pl. 9, fig. 7; Mitth. Jahrb. k. ungarn. geol. Anstalt, vol. 4, pt. 1, 1875 (1881), p. 80, pl. 9, fig. 7. (Upper Eocene-Lower Oligocene.)—Andrae, Abh. geol. Specialkarte Elsass-Loth., vol. 2, pt. 3, 1884, p. 155, pl. 9, fig. 3. (Middle Oligocene.)—Brady, Rep. Voy. Challenger, Zool., vol. 9, 1884, p. 706, pl. 107, figs. 6-7. (Recent.)—Cushman, U. S. Nat. Mus. Bull. 71, pt. 5, 1915, p. 71, pl. 29, fig. 1. (Recent.)

Test plano-convex; dorsal side nearly flat; ventral side strongly convex with deep umbilicus; chambers nine to eleven in the last whorl; sutures distinct, slightly depressed; wall very finely perforate; surface smooth; aperture an elongate slit between the periphery and the umbilicus on the inner margin of the chamber. Diameter, up to 0.5 mm. Abundant.

Genus **ANOMALINA** d'Orbigny, 1826

Genotype (first species, designated by Cushman, 1915) ***Anomalina punctulata*** d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 282, pl. 15, figs. 1-3. (Recent, Island of Mauritius.)—d'Orbigny, Foram. Foss. Bass. Tert. Vienne, 1846, p. 169.

Discorbina (part) Brady, Rep. Voy. Challenger, Zool., vol. 9, 1884, p. 648 ff., ***D. parisensis***, ***D. bertheloti***, ***D. rarescens***.

Truncatulina (part) Cushman, U. S. Geol. Surv. Bull. 676, 1918, p. 63; ***T. americana*** Cushman; U. S. Geol. Surv. Prof. Pap. 129 E, 1922, p. 97, pl. 20, figs. 7-8.

Anomalina (part) Cushman, U. S. Geol. Surv. Prof. Pap. 129 E, 1922, p. 98. ***Anomalina***, most species of authors, equals ***Planulina***.

Test free, plano-convex, convex and entirely embracing on the side opposite the aperture, depressed and partially embracing on the apertural side; whorls few; chambers numerous, closely appressed or inflated, rapidly enlarging; wall hyaline, conspicuously perforate, medium to coarse, but not as coarse as in *Cibicides*; surface smooth or punctulate; aperture a slit at the base of the septum extending from the umbilicus onto the periphery. Diameter, up to 0.75 mm.—Mostly in shallow water, but down to 2160 fathoms.—Cretaceous to Recent.

Anomalina differs from *Planulina* in being involute on one side; from *Discorbis* and *Cibicides* in being involute on the side opposite the aperture and somewhat involute on the spiral side. d'Orbigny's model of *Anomalina elegans* shows the characters of the genus better than does his figure of *A. punctulata*.

Anomalina mantaensis n. sp.

Plate 4, fig. 5

Truncatulina americana Cushman, U. S. Nat. Mus. Bull. 103, 1919, p. 68, pl. 23, fig. 2 a-c.—U. S. Geol. Surv. Prof. Pap. 129 E, 1922, p. 97, pl.

20, figs. 7-8. (Upper Oligocene), (Not Cushman, U. S. Geol. Surv. Bull. 676, 1918, p. 63.)

Discorbis sp. Cushman, U. S. Geol. Surv. Prof. Pap. 133, 1923, p. 39, pl. 6, figs. 5-6. (Lower Oligocene.)

Test plano-convex, dorsal side flat, ventral side convex, and entirely involute, umbilicate, with a clear boss in the umbilicus; the last whorl tends to embrace the spire on the dorsal side and is raised above the preceeding whorl, leaving a cleft in which the apertures open; periphery sharply angled, limbate; chambers about ten in the last whorl; sutures curved and limbate on both sides, of clear shell material, raised on the dorsal side, depressed on the ventral side; wall hyaline, conspicuously perforate, more coarsely than in *Rotalia*; aperture at the end of the chamber toward the spire, on the dorsal side of the test, covered in some cases with a small valvular flap, the apertures of about four chambers visible. Length, up to 0.48 mm.; breadth, up to 0.38 mm. Abundant.

Holotype. Columbia University Paleo. Coll. No. 19954.

Genus **CIBICIDES** Montfort, 1808

Cibicides allenii (Plummer)

Plate 4, fig. 6

Truncatulina allenii Plummer, Univ. Texas Bull. 2644, 1926 (1927), p. 144, pl. 10, fig. 4 a-c. (Eocene.)

Test discoidal, entirely involute on the ventral side, partially involute on the dorsal side, the ventral side more convex than the dorsal; periphery scarcely at all lobulate except the outside of the last two or three chambers, and bordered by a blunt keel of clear shell material; peripheral margin bluntly angled; chambers ten to twelve in the last whorl; sutures slightly curved, limbate and raised on the dorsal side, the sutures between the whorls raised into a spiral line, and fused with thickening covering the spire; sutures on the ventral side slightly curved, more so toward the outer ends, limbate, raised in the earlier part of the last whorl, depressed in the later part; center of the ventral side with a raised umbo of clear shell material; wall coarsely perforate; aperture on the periphery, with outer lip, and extending along the suture between the last two whorls on the dorsal side for a distance of three or four chambers. Diameter, up to 1.15 mm. Rare.

Cibicides dohertyi n. sp.

Plate 4, fig. 7

Test biconvex, depressed, the last whorl not embracing to the umbilicus on the ventral side, dorsal side nearly flat, ventral side slightly convex, with spiral depression under the periphery, and umbilicus filled with clear shell material but not raised into an umbo; peripheral margin sharp, keeled; periphery slightly lobulate; chambers eight to ten in the last whorl, narrow, slightly inflated on both sides of the test; sutures depressed, limbate, especially on the dorsal side, and much curved on both sides of the test; wall very coarsely perforate; surface smooth, with little secondary thickening; aperture narrow, with raised lip, at the base of the septal face on the inner periphery and continuing for half the length of a chamber on the dorsal side. Diameter, up to 1.3 mm. Abundant.

Holotype. Columbia University Paleo. Coll. No. 19955.

This species differs from *C. wuellerstorfi* in the thicker test, in the fewer, longer and less curved chambers, lack of embracing of the last whorl on the dorsal and ventral sides, and less pronounced dorsal portion of the aperture. It differs from *C. sandiegensis* Cushman and Hanna (Trans. San Diego Soc. Nat. Hist., vol. 4, 1927, p. 55, pl. 6, figs. 1 - 2) in the limbate sutures. It is very near to a *Planulina*.

This species is named for Mr. Henry L. Doherty, who has done much to encourage the study and application of micro-paleontology.

Cibicides haidingerii (d'Orbigny)

Plate 4, fig. 8

Rotalina haidingerii d'Orbigny, Foram. Foss. Bass. Tert. Vienne, 1846, p. 154, pl. 8, figs. 7-9. (Miocene.)

Truncatulina haidingerii Brady, Rep. Voy. Challenger, Zool., vol. 9, 1884, p. 663, pl. 95, fig. 7 a-c. (Recent.)

Test unequally biconvex, ventral side more convex than the dorsal and slightly umbilicate; periphery slightly lobulate; peripheral margin sharply rounded; chambers five to seven in the last whorl; sutures distinct, slightly curved on both sides of the test, limbate, and flush with the surface on the dorsal side and making an angle of sixty degrees with the periphery, radial and slightly depressed on the ventral side; wall thin, coarsely perforate; aperture a narrow slip at the base of the last chamber, on the periphery and extending for a distance of about one chamber on the dorsal side along the suture line. Diameter

up to .37 mm. Abundant.

Cibicides nucleata (Seguenza)

Plate 4, fig. 9

Truncatulina nucleata Seguenza, Atti R. Accad. Lincei, ser. 3, Mem. Cl. Sci. Fis., Math., Nat., vol. 6, 1880, p. 64, pl. 7, fig. 8. (Lower Miocene.)

Test unequally biconvex; dorsal side slightly convex with large umbo of clear shell material which is separated from the later part of the last whorl by a deep groove; ventral side strongly convex, with large umbo; periphery broadly rounded; chambers twelve to fifteen in the last whorl, narrow; sutures broadly limbate, often indistinct, curved on both sides of the test; wall very coarsely perforate on both sides, with a pellicle of thickening tissue in adult specimens which obscures the surface features; aperture a curved opening on the periphery at the base of the last chamber extending on the dorsal side along the suture line for a distance of three to six chambers. Diameter, up to 1.1 mm. Abundant.

The conspicuous umbo is the most characteristic feature of this species.

Cibicides ungeriana (d'Orbigny)

Plate 4, fig. 10

Rotalina ungeriana d'Orbigny, Foram. Foss. Bass. Tert. Vienne, 1846, p. 157, pl. 8, figs. 16-18. (Miocene.)

Truncatulina ungeriana Brady, Rep. Voy. Challenger, Zool., vol. 9, 1884, p. 664, pl. 94, fig. 9. (Recent.)—Cushman, U. S. Nat. Mus. Bull. 71, pt. 5, 1915, p. 36, pl. 17, fig. 2. (Recent.)

Test unequally biconvex, ventral side more so but depressed under the periphery and slightly umbilicate; periphery with sharp, narrow carina; chambers ten to twelve in the last whorl; sutures distinct, limbate on the dorsal side and depressed on the ventral side, slightly curved; wall very coarsely perforate, with thickening over the spire on the dorsal side which reduces the number of mural pores and enlarges those remaining, less coarse on the ventral side; aperture narrow at the base of the last chamber on the periphery, with raised lip, and extending along the suture line on the dorsal side for a distance of two or three chambers. Diameter, up to 1.15 mm. Abundant.

The Ecuador specimens differ from the type figure of *C. ungeriana* in having limbate sutures and are thicker dorsoventrally.

Cibicides wuellerstorfi (Schwager)

Plate 4, fig. 11

Anomalina wuellerstorfi Schwager, Novara-Exped., Geol. Theil, vol. 2, 1866, p. 258, pl. 7, figs. 105 and 107. (Pliocene.)

Truncatulina wuellerstorfi Brady Rep. Voy. Challenger, Zool., vol. 9, 1884, p. 662, pl. 93, figs. 8-9. (Recent.)—Cushman, U. S. Nat. Mus. Bull. 71,

pt. 5, 1915, p. 34, pl. 12, fig. 3. (Recent)

Test plano-convex, compressed; dorsal side flat or sometimes slightly concave, the last part of the whorl overlapping the earlier part, with thickening on the sutures and between the pores in gerontic specimens; ventral side convex, umbonate, with coarse granulation by secondary tissue especially in the early part of the last whorl; peripheral margin usually acute, often with blunt keel; chambers nine to twelve in the last whorl, increasing in size as added, narrow, much curved; sutures distinct, limbate, curved, especially in the later part of the test; wall very coarsely perforate on both sides; aperture a narrow curved slit on the periphery at the base of the last chamber, extending on the dorsal side along the suture between the last two whorls for a distance of two or three chambers. Diameter, up to 0.9 mm. Abundant.

This species is abundant in the late Tertiary and Recent, but is of rare occurrence in the Lower Tertiary.

Genus *PLANULINA* d'Orbigny, 1826

Planulina affinis (Hantken)

Plate 4, fig. 12

Pulvulina affinis Hantken, A magy. kir. föltdt, int. évkönyve, vol. 4, 1875 (1876), p. 68, pl. 10, fig. 6; Mitth. Jahrb. k. ungarn. geol. Anstalt, vol. 4, pt. 1, 1875 (1881), p. 78, pl. 10, fig. 6. (Lower Oligocene.)

Anomalina affinis Cushman and Applin, Bull. Am. Assoc. Pet. Geol., vol. 10, 1926, p. 180, pl. 9, figs. 1-2. (Eocene.)

Test involute, nearly bilaterally symmetrical, the ventral side the deeper, ovate in side view, elliptical in face view; biumbilicate, the dorsal umbilicus generally the larger; periphery broadly angled; chambers eleven to fourteen in the last whorl; sutures of clear shell material, very little depressed, more so in the later part of the last whorl; wall coarsely perforate, but not so coarse as in *Cibicides*; surface smooth; aperture a narrow elongate slit on the inner margin of the last septal face, extending on both sides of the periphery, more on the dorsal side, with slight lip. Diameter, 0.23-0.42 mm. Abundant.

Family CHILOSTOMELLIDAE Brady, 1884

Genus *SPHAEROIDINA* d'Orbigny, 1826

Sphaeroidina bulloides d'Orbigny var. *chilostomata* n. var. Plate 5, fig. 3

Test subspherical in outline; chambers globular, rapidly in-

creasing in size, four in the last whorl, the last about as large as all the others; sutures narrow, depressed; wall finely perforate; surface smooth; aperture a curved slit surrounded by a raised lip, situated at the base of the last spetal face just above the suture. Diameter, up to 0.43 mm. Abundant.

Holotype. Columbia University Paleo. Coll. No. 19956.

The aperture of this variety is shorter, much less curved and lacks the large tooth of *S. bulloides* d'Orbigny. The form is less nearly spherical than that of *S. austriaca* d'Orbigny and the aperture is more elongate. The aperture is similar to that of most of the genera of the *Pleurostomellidae*.

Family VERNEUILINIDAE Cushman, 1927

Genus VERNEUILINA d'Orbigny, 1840

Verneuilina cyclostomata n. sp.

Plate 5, fig. 2

Test subconical, apical end bluntly rounded, apertural end broadly rounded; chambers three to four to a whorl, the early ones small, the later ones rapidly enlarging, the last whorl composing half the test; sutures indistinct, slightly depressed; wall finely arenaceous; surface fairly smooth; aperture in a depression at the base of the last chamber, round, with raised rim. Length, up to 0.87 mm. Abundant.

Holotype. Columbia University Paleo. Coll. No. 19957.

This species resembles *Verneuilina siphonella* (Reuss) in many respects, but it has fewer chambers in a whorl, and the septal face is concave rather than convex.

Genus GUADRYINA d'Orbigny, 1839

Gaudryina globulifera Reuss

Plate 5, figs. 3, 4

Gaudryina globulifera Reuss, Zeitschr. deutsch. geol. Gesell., vol. 4, 1852, p. 18, fig. a-b. (Oligocene.)

Gaudryina chilostoma var. *globulifera* Andreae, Abh. geol. Specialkarte Elsass-Lothr., vol. 2, pt. 3, 1884, p. 200, pl. 7, figs. 8-9. (Oligocene.)

Test elongate, triangular in side view, rapidly enlarging, about two-thirds as broad as long, triserial portion composing about one-half of the test; chambers inflated except for the early triserial ones; sutures distinct, depressed; wall very finely arenaceous; surface smooth, white; aperture a narrow slit at the base of the inner margin of the last chamber, with slight lip. Length, 0.5 mm.; breadth, 0.35 mm. Abundant.

Genus *CLAVULINA* d'Orbigny, 1826*Clavulina curta* n. sp.

Plate 5, fig. 5

Clavulina parisiensis Flint (not d'Orbigny), Rep. U. S. Nat. Mus. for 1897 (1899), p. 289, pl. 35, fig. 2. (Recent.)

Test elongate, short, robust, slightly curved, apertural end inflated, triserial portion subpyramidal, later portion cylindrical and of smaller diameter than the triserial portion; chambers three to six in the uniserial portion, slightly inflated, shorter than broad, irregular in length; sutures slightly depressed, very obscure in the triserial portion; wall coarsely arenaceous with much calcareous cement, white; surface rough; aperture terminal, central, round, with narrow rim and small tooth. Length, 1.37 mm. Common.

Holotype. Columbia University Paleo. Coll. No. 19958.

This species differs from *C. parisiensis* d'Orbigny, in the shorter and less regular form, more inflated chambers, and particularly in the inflated apertural end.

Clavulina pallida Cushman

Plate 5, figs. 6, 7

Clavulina communis var. *pallida* Cushman, Bull. Scripps Inst. Ocean., tech. ser., vol. 1, 1927, p. 138, pl. 2, fig. 1. (Recent.)

Test elongate, nearly straight, triserial portion conical, uniserial portion subcylindrical, gradually enlarging, less in diameter than the triserial portion; apertural end truncate; chambers in the triserial portion about nine, later portion consisting of uniform, cylindrical chambers which are about half as high as wide; sutures well marked in some specimens, obscure in some, especially in the triserial portion; wall finely arenaceous, white; surface smooth; aperture central, round or oval, at the end of a short neck, which is situated in a depression. Length, up to 1.5 mm.; breadth, 0.6 mm. Common.

This species closely resembles *Clavulina clavata* Cushman from the Upper Cretaceous of Mexico (Bull. Am. Assoc. Pet. Geol., vol. 10, 1926, p. 586, pl. 17, fig. 4), but the chambers are shorter. It is like *C. parisiensis* d'Orbigny except that the triserial portion is not triangular and the walls are finer grained. It differs from *C. communis* d'Orbigny in the relatively shorter chambers and the truncate apertural end.

Family TEXTULARIIDAE d'Orbigny, 1846

Genus TEXTULARIA Defrance, 1824

Textularia flabelliformis Gümbel

Plate 5, fig. 8

Textularia flabelliformis Gümbel, Abh. k. bay. Wiss., München, Math.-Phys. Cl., vol. 10, for 1868 (1870), p. 647, pl. 2, fig. 83 a-b. (Eocene.)

Test cuneiform, flattened, more so in the broadly rounded early portion; edges sharp; chambers seven to ten pairs, very much broader than long; sutures elevated, curved, making a median ridge where the two series of chambers join; wall coarsely arenaceous; aperture an elongate slit at right angles to the plane of flattening, situated in a reentrant at the base of the septal face, and about one-third as long as the width of the septal face. Length, up to 1 mm.; breadth, up to 0.9 mm.; thickness, up to 0.6 mm. Abundant.

This species is like the young of *Vulvulina*, but in the many specimens we have, none of the chambers are uniserial and the aperture is not like that of *Vulvulina*. It is probably the form from which *Vulvulina* was derived.

Family HETEROHELICIDAE Cushman, 1927

Genus BOLIVINA d'Orbigny, 1839

Bolivina applinae Plummer

Plate 5, fig. 9

Bolivina applini Plummer, Univ. Texas Bull. 2644, 1926 (1927), p. 69, pl. 4, fig. 1. (Eocene.)

Test elongate, slightly flattened, obtusely pointed, sides nearly parallel, edges rounded; early portion with fine longitudinal costae, later portion smooth except for crenulations along the suture lines; chambers eight or nine on a side; aperture on elongate slit at the base of the last chamber. Length, 0.36 mm.; breadth, 0.14 mm. Rare.

This species resembles *B. nobilis* Hantken and *B. advena striatella* Cushman (Contrib. Cushman Lab. Foram. Res., vol. 1, pt. 2, 1925, p. 30, pl. 5, fig. 3 a-b) but differs in being less compressed and in having crenulations along the suture lines between the later chambers. *B. advena striatella* Cushman has many more chambers than this species.

***Bolivina pisciformis* n. sp.**

Plate 5, fig. 10

Test elongate, flattened, with a sharp, narrow, serrate keel of clear shell material, initial end angled and often with an apical spine; chambers eight to twelve on a side, about twice as broad as high, meeting at an angle of about 99° ; sutures distinct, of clear shell material; wall thin, very finely perforate; surface smooth except for the keel which has numerous short, sharp spines at the end of each chamber; aperture an elongate slit. Length, up to 0.65 mm.; breadth, up to 0.25 mm. Abundant.

Holotype. Columbia University Paleo. Coll. No. 19959.

This species resembles *B. alazanensis* Cushman (Contrib. Cushman Lab. Foram. Res., vol. 1, pt. 4, 1926, p. 82, pl. 12, fig. 1) but differs in having narrower chambers which meet at a smaller angle (just a little more than 90°). It differs from *B. alata* (Seguenza) in having narrower chambers and being broader at the top.

Genus PLECTOFRONDICULARIA Liebus, 1902***Plectofrondicularia californica* Cushman and Stewart**

Plate 5, fig. 11

Plectofrondicularia californica Cushman and Stewart, Contrib. Cushman Lab. Foram. Res., vol. 2, pt. 2, 1926, p. 39, pl. 6, figs. 9-11. (Lower Pliocene.)

Test very elongate, flattened, straight or curved at the apical end, with sides nearly parallel and flat or slightly concave, with three sharp costae on each edge, and a short costa on each side of the apical end; apical end bluntly rounded or bluntly pointed in microspheric specimens; chambers biserial in the early portion, consisting of from four to seven pairs of chambers, uniserial in the later portion and gradually increasing in height; sutures distinct, broad, very slightly depressed, of clear shell material, curved towards the apertural end; wall hyaline, very finely perforate; surface smooth, except for the costae; aperture terminal, central, oval, not definitely radiate, but with inwardly pointing teeth in adult specimens. Length of incomplete specimens, 1 mm.; breadth, 0.25 mm. Abundant.

The Ecuador specimens differ from the California specimens only in having a longer biserial stage and a longer central costa.

Plectofrondicularia miocenica Cushman

Plate 5, fig. 12

Plectofrondicularia miocenica Cushman, Contrib. Cushman Lab. Foram. Res., vol. 2, pt. 3, 1926, p. 58, pl. 7, figs. 10-11; pl. 8, figs. 11-12. (Miocene.)

Test much flattened, elliptical in cross section, tapering rapidly to a blunt point at the apical end; edge carinate; chambers ten in a broken specimen, closely appressed, early ones biserial, later ones uniserial; sutures distinct, of clear shell material; wall thin; surface smooth except in the early portion where there are five, short costae which begin on the proloculum and spread and disappear in the next few chambers; aperture terminal, central, oval. Length of broken specimen, 0.35 mm. Rare.

Family BULIMINIDAE Jones, 1876**Genus BULIMINA** d'Orbigny, 1826**Bulmina inflata** Seguenza

Plate 5, fig. 13

Bulmina inflata Seguenza, Atti Accad. Gioenia Sci. Nat., Catania, ser. 2, vol. 13, 1862, p. 109, pl. 1, fig. 10. (Pleistocene.)—Cushman, U. S. Nat. Mus. Bull. 71, pt. 2, 1911, p. 84, fig. 137 a-b. (Recent.)—Cole, Bull. Am. Pal., vol. 14, no. 51, 1927, p. 25, pl. 3, fig. 12. (Eocene.)

Test ovate, tapering to a sharp spine at the apical end; chambers numerous, inflated, rapidly increasing in size as added; wall thick; surface smooth except for crenulations on the lower sides of the chambers which extend beyond the margin forming stout spines; aperture a comma-shaped opening on the inner face of the last-formed chamber, with small, plate-like tooth. Length, 0.52 mm.; breadth, 0.45 mm. Abundant.

Genus VIRGULINA d'Orbigny, 1826**Virgulina bramlettei** n. sp.

Plate 5, fig. 14

Test elongate, subcylindrical, slightly flattened, apical and apertural ends bluntly pointed; chambers about eight, rapidly increasing in height as added, not inflated, early chambers triserial, later ones biserial; sutures distinct, slightly depressed, of clearer shell material; wall thick, very finely perforate; surface smooth; aperture comma-shaped, at the end of the last chamber. Length, 0.6 mm. Rare.

Holotype. Columbia University Paleo. Coll. No. 19960.

This species differs from *V. dibollensis* Cushman and Applin (Bull. Am. Assoc. Pet. Geol., vol. 10, 1926, p. 168, pl. 7, fig. 7), in the longer chambers. It is named for Mr. M. N. Bramlette, who collected the material.

Family UVIGERINIDAE Galloway and Wissler, 1927

Genus UVIGERINA d'Orbigny, 1826

***Uvigerina alata* Cushman and Applin**

Plate 6, fig. 1

***Uvigerina alata* Cushman and Applin, Bull. Am. Assoc. Pet. Geol., vol. 10, 1926, p. 176, pl. 8, figs. 11-13. (Upper Eocene.)**

Test fusiform, apical end bluntly rounded or pointed, apertural end truncate; composed of four to five whorls; chambers slightly inflated, three to a whorl, increasing in size as added; sutures depressed; surface ornamented with from twelve to eighteen high costae, which are prominent in the early part, and extend beyond the bases of the chambers, but fade out anteriorly, leaving the last one or two chambers smooth; aperture round, with phialine lip, at the end of a short neck which is situated in a prominent depression. Length, up to 1 mm. Common.

The Ecuador specimens are shorter and the costae are stronger than the Texas specimens of this species.

***Uvigerina beccarii* Fornasini**

Plate 6, fig. 2

***Uvigerina beccarii* Fornasini, Rend. Sess. R. Accad. Sci. Isti. Bologna, n. s., vol. 2, 1898, p. 14, pl. 1, fig. 5. (Pliocene.)**

Test robust, short, pyriform, apertural end truncate, tapering to a blunt point at the apical end, composed of two or three whorls; chambers slightly inflated, three to a whorl except for the last whorl which has only two chambers; sutures very little depressed and indistinct; surface ornamented in the first third or half, with about six prominent costae which extend across the sutures and between which are small striae; all the costae are irregular and fade out in the last half of the test; wall thick, with secondary layers, white; aperture round, at the end of a short neck, with phialine lip; the neck arises from a depression extending down to the base of the chamber. Length, up to 0.9 mm. Abundant.

The pyriform shape, irregular costae in the early part of the test, and the apertural depression, are characteristic. This species

and the one identified as *U. alata* are obviously closely related. Young specimens are globular and striate.

***Uvigerina hispida* Schwager**

Plate 6, fig. 3

***Uvigerina hispida* Schwager, Novara-Exped., Geol. Theil, vol. 2, 1866, p. 249, pl. 7, fig. 95. (Pliocene.)**

***Uvigerina auberiana* Brady (not d'Orbigny), Rep. Voy. Challenger, Zool., vol. 9, 1884, p. 579, pl. 75, fig. 9. (Recent.)**

Test fusiform, widest near the apical end, composed of about five whorls, three chambers to a whorl in the early part, two to a whorl in the middle and later part; chambers inflated; sutures depressed; surface covered with short, thick spines, not arranged in lines; aperture large, round, at the end of a short neck with phialine lip. Length, up to 1 mm. Abundant.

***Uvigerina proboscidea* Schwager**

Plate 6, fig. 4

***Uvigerina proboscidea* Schwager, Novara-Exped., Geol., Theil, vol. 2, 1866, p. 250, pl. 7, fig. 96. (Pliocene.—Cushman, U. S. Nat. Mus. Bull. 71, pt. 3, 1913, p. 94, pl. 42, fig. 2. (Recent.)**

Test elongate, fusiform or pyriform, composed of four to five whorls, apical end rounded; chambers inflated, arranged tri-serially except the last whorl which is composed of two chambers; sutures sharply depressed; surface covered with small, short spines, not arranged in any regular manner; aperture terminal, round, at the end of a long neck, with phialine lip. Length, up to 0.76 mm. Abundant.

***Uvigerina pygmaea* d'Orbigny**

Plate 6, fig. 5

***Uvigerina pigmea* d'Orbigny, Ann., Sci. Nat., vol. 7, 1826, p. 269, pl. 12, figs. 8-9. (Pliocene); Modèles, no. 67, 1826. (Spelled pygmea on explanation of plates.)**

Test elongate, fusiform, apical end bluntly rounded; chambers three to a whorl, slightly inflated; sutures distinct, depressed; surface covered with numerous, well-defined costae which are not continuous beyond the suture lines of each chamber, nine or ten on each side of the test, highest in the central portion of the test, lacking in the last few chambers, which are covered with fine, short spines; aperture terminal, round, small, at the end of a long neck, with a slight phialine lip. Length, up to 0.56 mm. Common.

Most species identified as *U. pygmaea* are not that species.

Family CASSIDULINIDAE d'Orbigny, 1846

Genus CASSIDULINA d'Orbigny, 1826

Cassidulina subglobosa Brady

Plate 6, fig. 6

Cassidulina subglobosa Brady, Quart. Jour. Micr. Sci., n. s., vol. 21, 1881, p. 60; Rep. Voy. Challenger, Zool., vol. 9, 1884, p. 430, pl. 54, fig. 17 a-c. Sherborn and Chapman, Jour. Roy. Micr. Soc., ser. 2, vol. 6, 1886, p. 744, pl. 16, fig. 2 a-b.—Brady, Parker and Jones, Trans. Zool. Soc. London, vol. 12, ser. 7, 1888, p. 221, pl. 43, figs. 12-14.—Cushman, U. S. Nat. Mus. Bull. 71, pt. 2, 1911, p. 98, fig. 152 a-c. (Recent.)

Test subglobular, irregular in outline, somewhat compressed on both sides; chambers few, inflated, alternating; sutures depressed; wall very finely perforate; surface smooth; aperture a large virguline opening extending up into the last septal face obliquely to the plane of coiling. Diameter, 0.2-0.56 mm. Abundant.

Family PLEUROSOMELLIDAE Reuss, 1860

Genus PLEUROSOMELLA Reuss, 1860

Pleurostomella alternans Schwager

Plate 6, figs. 7, 8

Pleurostomella eoceana Gümbel, Abh. k. bay. Ak. Wiss., München, Math.-1866, p. 238, pl. 6, figs. 79-80. (Pliocene.)—Brady, Rep. Voy. Challenger, Zool., 9, 1884, p. 412, pl. 51, figs. 22-23. (Recent.)—Pummer, Univ. Texas, Bull. 2644, 1926 (1927), p. 69, pl. 4, fig. 2 a-b, (Eocene.)—Cushman, Contrib. Cushman Lab. Foram. Res., vol. 3, pt. 2, 1927, p. 129, pl. 25, figs. 7-8.

Pleurostomella eoceana Gümbel, Abh. k. bay. Ak. Wiss., München, Math.-Phys. Cl., vol. 10, for 1868 (1870), p. 630, pl. 1, fig. 53 a-b. (Eocene.)

Test elongate, tapering to a blunt point at the apical end; chambers six to ten, rapidly enlarging, longer than broad, the last chamber constituting about a third of the test; biserial and staggered except the initial end of the microspheric form, which is triserial; sutures distinct, deep in the later part of the test; surface smooth; aperture an arched opening with a notch in the lower side, situated in a large depression. Length, 0.28 mm. and 0.59 mm.; breadth, 0.1 mm. and 0.16 mm. Rare.

Genus NODOSARELLA Rzehak, 1895

Genotype (designated by Cushman, 1928) *Lingulina tuberosa* Gümbel, Abh. k. bay. Ak. Wiss., München, Math.-Phys. Cl., vol. 10, for 1868 (1870), p. 629, pl. 1, fig. 52, (Eocene, Bavarian Alps.)

Nodosarella Rzehak, Ann. k. k. naturhist. Hofmuseums, vol. 10, 1895, p. 220.—Silvestri, Atti Soc. Ital. Sci. Nat., vol. 64, 1925, p. 52—Cushman, Foraminifera, 1928, p. 261.

Ellipsonodosaria Silvestri, Atti Rend. R. Accad. Sci. Lett. Arti Zelanti, Acireale, Mem. Cl. Sci., vol. 10, 1900, p. 4; monotype, **Lingulina rotundata** d'Orbigny; Riv. Ital. Pal., anno 29, 1923, p. 15; Boll. Soc. Geol. Ital. Sci. Nat., Mus. Civ. Stor. Nat. Milano, vol. 62, 1923, p. 345.

Test free, elongate, round or nearly so in cross section; chambers several, uniserial, regularly arranged or staggered in the early portion of the test; wall calcareous, hyaline, very finely perforate; surface smooth, costae or spinose; aperture terminal, crescentic, with calcareous grooved column extending downward from the concave side of the aperture. Length, up to 3 mm. Shallow water sediments.—Lower Cretaceous to Pliocene.

Nodosarella may be a synonym of *Stilostomella*.

Nodosarella camerani (Dervieux)

Plate 6, figs. 9-11

Nodosaria Camerani Dervieux, Boll. Soc. Geol. Italiana, vol. 12, 1893 (1894), p. 612, pl. 5, figs. 40-41. (Eocene.)

Ellipsonodosaria Camerani Silvestri, Riv. Ital. Pal., anno 29, 1923, p. 16, pl. 2, figs. 4-12. (Eocene.)

? **Nodosaria cocoaensis** Cushman, Contrib. Cushman Lab. Foram. Res., vol. 1, pt. 4, 1925, p. 66, pl. 10, figs. 5-6. (Eocene.)

? **Dentalina cocoaensis** Cushman, Jour. Pal., vol. 1, no. 2, 1927, p. 153, pl. 24, fig. 14. (Lower Oligocene, Alazan shale.)

Test elongate, subcylindrical, curved, with one or two short, eccentrically placed apical spines; chambers nine to fourteen, gradually enlarging in the microspheric form, of about equal size in the megaspheric form; sutures distinct, not oblique, of clear shell material, flush in the early part but constricted between the later chambers; wall thick of concentric layers, surface smooth; aperture terminal, kidney shaped, with vertical tooth. Length, up to 3 mm. Abundant.

We consider this species the most important one in the fauna as indicating the age of the fauna. The Ecuador specimens seem to be identical with the Italian ones, although the specimens vary much in details. It seems probably that *Nodosaria cocoaensis* Cushman of the Upper Eocene of Alabama and Lower Oligocene of Mexico is the same species. He does not mention the aperture.

Nodosaria camerani (Dervieux) cannot be the genotype of *Siphonodosaria*, as stated by Cushman, Foraminifera, 1928, p. 257, for Silvestri distinctly states (Boll. Soc. Geol. Ital., vol. 42, 1923 (1924), p. 18) that he considers it an *Ellipsonodosaria*.

Nodosarella paucistriata n. sp.

Plate 6, fig. 12

Test elongate, subcylindrical, tapering, curved; chambers six or seven in a broken specimen, bulbous, gradually enlarging; sutures constricted, crossed by short striae, which become obsolescent on the middle of the chambers; wall thick, finely perforate, composed of concentric layers; surface smooth; aperture terminal, produced, kidney-shaped, sometimes with tooth. Length, up to 1.8 mm. Abundant.

Holotype. Columbia University Paleo. Coll. No. 19961.

The striae across the sutures in this form seem to make it a new species, as no striate or costate species have been described. This species is like *Nodosaria tholigera* Schwager except for the round, radiate aperture in that form.

Genus DAUCINA Bornemann, 1855

Genotype (monotypic) *Daucina ermaniona* Bornemann, Erman's Archiv. Wiss. Kunde Russland, vol. 14, 1855, pp. 153-154, pl. 1, figs. 5-15. (Tertiary, near Rio de Janeiro at Corcovado.)

Ellipsoglandulina Silvestri, Atti Rend. R. Accad. Sci. Lett. Arti Zelanti, Acireale, Mem. Cl. Sci., vol. 10, 1900, p. 9, pl. figs. 3-10, 12, 13. (Miocene or Pliocene, Zanclean, Borfornello, Termini-Imerese, Sicily.)—Silvestri, Atti R. Accad. Sci. Torino, vol. 38, 1903, p. 213; Atti Soc. Ital. Sci. Nat., vol. 64, 1925, p. 51, fig. 2.

Test free, oval; chambers several, arranged in a rectilinear manner or curved in the early portion of the test, rapidly enlarging, each embracing much of the previous one; wall calcareous, finely perforate, smooth or costate; aperture terminal, crescentic, with or without notch in the concave side, with internal column. Length, up to 2 mm.—Shallow water deposits.—Cretaceous and Eocene of Mexico; Tertiary of Brazil; Oligocene to Pliocene of Italy.

Daucina multicostata n. sp.

Plate 6, fig. 13

Test straight, except for the apical end which is curved, tapering, initial end sharply pointed; chambers four to six, early ones compressed, later ones bulbous and distinct; sutures depressed; surface throughout ornamented with eighteen to twenty-two fine, longitudinal costae which cease near the middle of the last chamber; aperture terminal, crescentic. Length, 0.46 - 0.8 mm. Common.

Holotype. Columbia University Paleo. Coll. No. 19962.

This species is the only costae one of the genus so far known.

Genus **ELLIPSOLAGENA** Silvestri, 1924

Ellipsolagena ventricosa (Silvestri)

Plate 6, fig. 14

Lagena ventricosa Silvestri, Atti R. Accad. Sci. Torino, vol. 39, 1903, pp. 10-11, fig. 6 a-e. (Miocene.)

Ellipsolagena ventricosa Cushman, Contrib. Cushman Lab. Foram. Res., vol. 3, pt. 3, pt. 1, 1927, p. 71, pl. 15, fig. 10.

Test spherical, circular in side view, broadly elliptical in apertural view, with a short apical spine; wall hyaline, very finely perforate; surface smooth except for a short raised keel at the apertural end; aperture an elliptical slit just below the keel, with an internal tube. Length, 0.26 mm.; breadth, 0.22 mm. Rare.

This species somewhat resembles *Lagena apiculata* Brady (not Reuss) Rep. Voy. *Challenger*, Zool., vol. 9, 1884, p. 453, pl. 56, figs. 15-18, which is an *Ellipsolagena*, but differs in being more perfectly spherical.

Family **NONIONIDAE** Reuss, 1860

Genus **NONION** Montfort, 1808

Nonion pompilioides (Fichtel and Moll)

Plate 6, fig. 15

Nautilus pompilioides Fichtel and Moll, Test. Micr. 1798, p. 31, pl. 2, figs. a-c. (Pliocene-Recent)

Nonionina pompilioides Brady, Rep. Voy. *Challenger*, Zool., vol. 9, 1884, p. 727, pl. 109, figs. 10-11. (Recent.)

Test bilaterally symmetrical, subcircular in side view, oval in face view, deeply umbilicate, axial diameter increasing slowly; chambers eight to nine in the last whorl; sutures distinct, of clear shell material, not depressed; wall conspicuously perforate; aperture a long narrow slit on the inner margin of the last septal face, with slight lip. Diameter, 0.21 - 0.5 mm. Abundant.

This species differs from *N. umbilicata* (d'Orbigny) in the fewer chambers and greater diameter of the early whorls.

Genus **PULLENIA** Parker and Jones, 1862

Pullenia bulloides (d'Orbigny)

Plate 6, fig. 16

Nonionina bulloides d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 293, no. 2; Foram. Foss. Bass. Tert. Vienne, 1846, p. 107, pl. 5, figs. 9-10. (Miocene.)

Test spheroidal, bilaterally symmetrical, axial diameter nearly

or quite equal to the equatorial; chambers four in the last whorl; sutures narrow, distinct, straight or slightly curved and radial as seen from the side of the test; wall very finely perforate; surface smooth; aperture a narrow slit at the base of the last septal face. Diameter, up to 0.38 mm. Abundant.

Pullenia quinqueloba (Reuss)

Plate 6, fig. 17

Nonionina quinqueloba Reuss, Zeitschr. deutsch. geol. Gesell., vol. 3, 1851, p. 71, pl. 5, fig. 31. (Middle Oligocene.)

Pullenia quinqueloba Brady, Rep. Voy. Challenger, Zool., vol. 9, 1884, p. 617, pl. 84, figs. 14-15. (Recent.)—Brady, Parker and Jones, Trans. Zool. Soc. London, vol. 12, pt. 7, 1888, p. 226, pl. 43, figs. 22-23. (Recent.)—Franke, Abh. Ber. Mus. Natur. Heimatk., Naturw. Ver. Magdeburg, vol. 4, pt. 2, 1925, p. 188, pl. 6, fig. 70. (Lower Oligocene.)

Test nautiloid, biconvex, somewhat compressed; periphery slightly lobulate; peripheral margin broadly rounded; chambers five in the last whorl; sutures slightly depressed and curved; surface smooth and glossy; aperture a long, narrow slit at the base of the last septal face, with upper lip. Diameter, 0.3 mm.; breadth, 0.2 mm. Rare.

PLATES I - 6

EXPLANATION OF PLATE 1

FIGURE

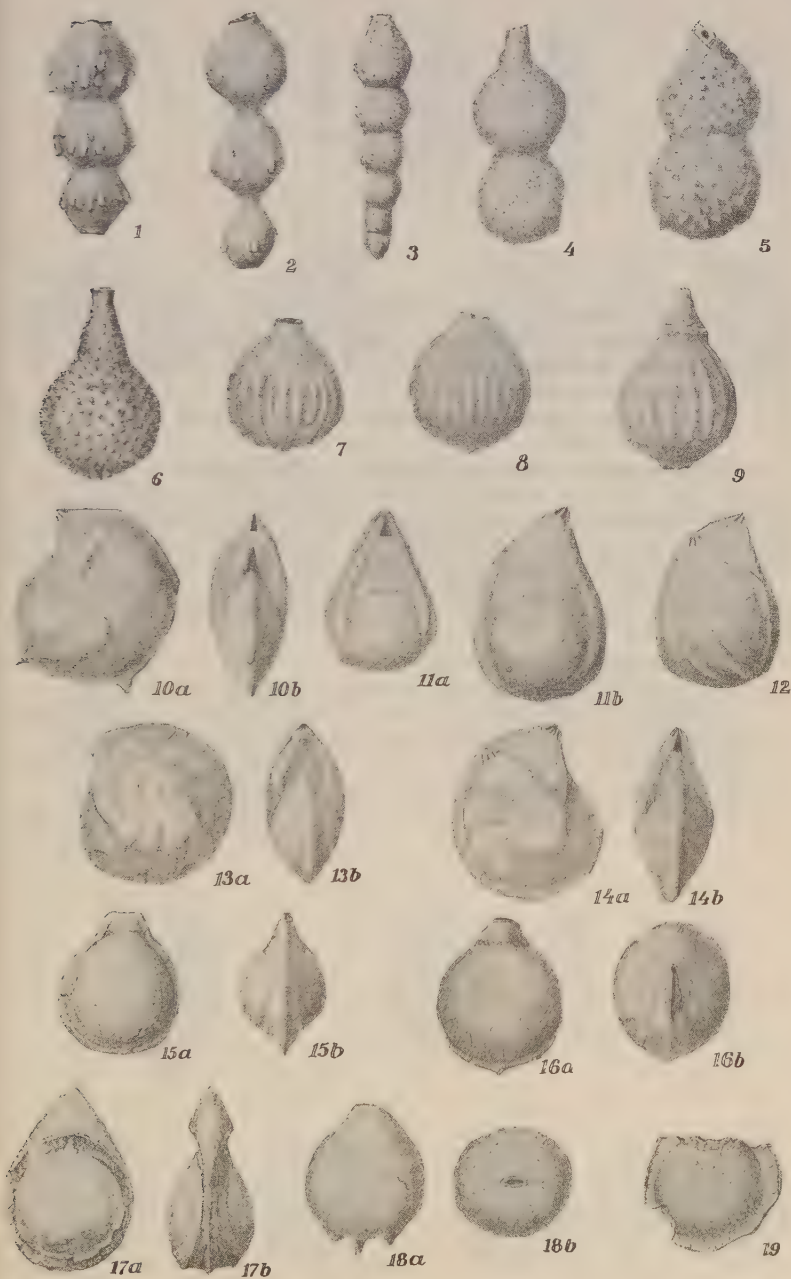
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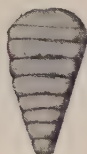


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1



2a



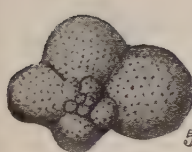
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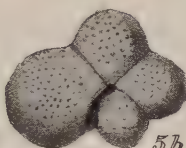
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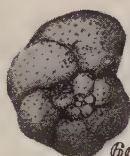
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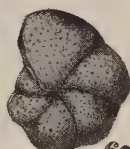
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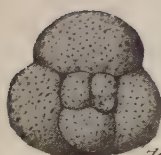
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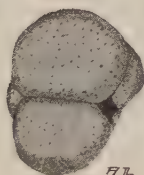
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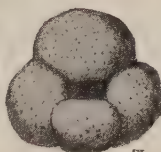
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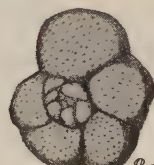
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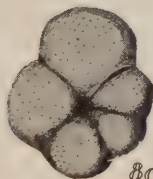
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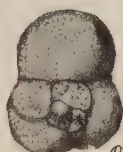
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8c



9a



9b



10



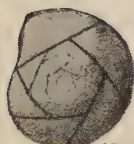
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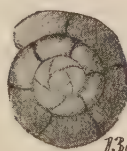
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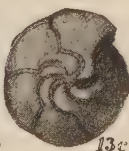
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13a



13b



13c

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